CLAIMS

1. A fuel cell system having: a fuel cell (1) generating power as a result of chemical reactions between supplied gases, wherein a coolant flows in the fuel cell and undergoes a temperature increase as a result of absorbing waste heat produced by power generation in the fuel cell; a water tank (31); a humidifying device (34) for humidifying at least one supplied gas by using water from the water tank (31); and a coolant temperature regulation device for regulating a temperature of the coolant flowing inside the fuel cell (1) so as to control the temperature of the fuel cell (1);

the fuel cell system comprising:

a defrosting device (61) for melting ice in the water tank by applying heat of the coolant to the water tank (31);

a coolant recirculation passage (22, 25, 95) for allowing a recirculation of the coolant through the defrosting device (61) and the fuel cell (1);

a flow generator (21) for generating a flow of the coolant from the fuel cell (1) to the defrosting device (61); and

a controller (51) for controlling a startup operation of the fuel cell system, the controller having the function of controlling the flow generator (21) to generate a flow of coolant from the fuel cell (1) to the defrosting device (61) so as to melt ice in the water tank (31) while the startup operation of the fuel cell system.

2. The fuel cell system as defined by Claim 1, wherein the defrosting device (61) is disposed in the water tank (31) and comprises a heat exchanger (61) allowing heat exchange between the coolant and ice in the water tank (31).

3. The fuel cell system as defined by Claim 2, further comprising a heater (65) for heating the coolant discharged from the defrosting device (61).

4. The fuel cell system as defined by Claim 3, further comprising a

temperature sensor (83) for detecting a temperature of the coolant;

wherein the coolant temperature regulation device comprises:

a radiator (26) provided on the coolant recirculation passage;

a first bypass passage (27) branching from the coolant recirculation passage and bypassing the radiator (26), the heater (65) being disposed in the first bypass passage (27); and

a passage switching device (28) for selectively switching the passage for the coolant between a passage passing through the radiator (26) and a passage passing through the first bypass passage (27);

and wherein the controller further functions to control the passage switching device (28) in response to a detected temperature of the coolant so as to regulate the temperature of the coolant.

5. The fuel cell system as defined by Claim 4, wherein the water tank (31) is disposed in the coolant recirculation passage upstream of the position at which the first bypass passage (27) branches from the recirculation passage.

6. The fuel cell system as defined by Claim 3, further comprising a temperature sensor (83) for detecting a temperature of the fuel cell (1);

wherein the controller further functions to compare the detected temperature of the fuel cell (1) with freezing point of water; operate the heater (65) when the detected temperature of the fuel cell (1) is less than freezing point; and stop the operation of the heater (65) when the detected temperature of the fuel cell (1) is greater than or equal to freezing point.

7. The fuel cell system as defined by Claim 2, further comprising:

a second bypass passage (91) branching upstream of the water tank (31) and bypassing the water tank (31); and

a passage switching device (92) for switching the passage for the coolant between a passage passing through the heat exchanger (61) in the water tank (31) and a passage passing through a second bypass passage.

8. The fuel cell system as defined by Claim 7, further comprising a temperature sensor (83) for detecting a temperature of the fuel cell (1),

wherein the controller (51) further functions to compare the detected temperature of the fuel cell (1) with freezing point of water; control the passage switching device (92) so that the coolant flows through the second bypass passage when the detected temperature of the fuel cell (1) is less than freezing point; and control the passage switching device (92) so that the coolant flows through the heat exchanger in the water tank when the detected temperature of the fuel cell (1) is greater than or equal to freezing point.

9. A fuel cell system having: a fuel cell (1) generating power as a result of chemical reactions between supplied gases, wherein a coolant flows in the fuel cell and undergoes a temperature increase as a result of absorbing waste heat produced by power generation in the fuel cell; a water tank (31); a humidifying device (34) for humidifying at least one supplied gas by using water from the water tank (31); and a coolant temperature regulation device for regulating a temperature of the coolant flowing inside the fuel cell (1) so as to control the temperature of the fuel cell (1);

the fuel cell system comprising:

a defrosting means (61) for melting ice in the water tank by applying heat of the coolant to the water tank (31);

a coolant recirculation passage means (22, 25, 95) for allowing a recirculation of the coolant through the defrosting means (61) and the fuel cell (1);

a flow generating means (21) for generating a flow of the coolant from the fuel cell (1) to the defrosting means (61); and

a control means (51) for controlling the flow generator (21) to generate a flow of coolant from the fuel cell (1) to the defrosting means (61) so as to melt ice in the water tank (31) while a startup operation of the fuel cell system.

10. A control method for controlling a fuel cell system, the fuel cell system having: a fuel cell (1) generating power as a result of chemical reactions between supplied gases, wherein a coolant flows in the fuel cell and undergoes a temperature increase as a result of absorbing waste heat produced by power generation in the fuel cell; a water tank (31); a humidifying device (34) for humidifying at least one supplied gas by using water from the water tank (31); and a coolant temperature regulation device for regulating a temperature of the coolant flowing inside the fuel cell (1) so as to control the temperature of the fuel cell (1);

the control method comprising the steps of:

providing a defrosting device (61) for melting ice in the water tank by applying heat of the coolant to the water tank (31);

providing a coolant recirculation passage (22, 25, 95) for allowing a recirculation of the coolant through the defrosting device (61) and the fuel cell (1); and

generating a flow of coolant from the fuel cell (1) to the defrosting device (61) so as to melt ice in the water tank (31) while a startup operation of the fuel cell system.